PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Oil Maintenance Units

We, BRIGGS CLARIFIER COMPANY, a Corporation organized and existing under the laws of the State of Delaware, United States of America, of 1339, Wisconsin Avenue, N.W., Washington, District of Columbia, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to reconditioning the lubricating systems of internal combustion engines, and more particularly to a method and apparatus for periodically clarifying the lubricating oil and at the same time cleaning the lubricating system of the engine, utilizing the lubricating oil as a flushing medium for the system. The invention finds particular application in the maintenance of airplane engines and will be described with respect thereto, it being understood, however, that it is not limited to the aviation field.

There are many factors which lead to the contamination of lubricating oil during the normal operation of an airplane. Among them are flight temperatures, engine blow-by, normal engine wear, high bearing loads, and such air base conditions as blowng dust and sand. This contamination is both chemical and physical caused by the formation of gums and acids in the oil and the depositions in the oil of solid particles such as metal chips, dust, carbon particles and the like. When the contamination reaches a very small percentage, the foreign matter, particularly gums, begin to deposit out in the engine itself, oil tanks, oil coolers and oil lines and, as the deposits increase, they materially affect the normal heat balance of the engine, restrict oil cooling, increase engine wear, and impair the full power delivery and efficiency of the engine.

Draining the contaminated oil out of the system will not remove or change the character of these deposits. On the other hand, it has been found that when kept visually clear and free of dissolved gums and acids, the same oil that lubricates the engine is an efficient solvent for these impurities. This property of lubricating oil is utilized in engine installations capable of including a proper oil clarifying system as a permanent part of the lubricating circuit whereby the contaminating matter may be continuously removed from the oil during its circulation. In aircraft installations, however, an oil clarifying unit sufficiently large to effectively clean the oil exceeds the size and weight limits permitted in the airplane and as a consequence periodic reconditioning of the airplane lubricating system must be resorted to.

The usual method of reconditioning the lubricating system of an airplane engine is, when the oil becomes contaminated, to drain off the old oil and refill with fresh oil. While draining the old oil obviously removes contaminating matter which is suspended in oil, draining, as stated above, does not remove the contaminants which have accumulated as deposits in the lubricating system. This is easily shown by the condition of the fresh oil after a few minutes run of the engine. Even when the system is flushed out with flushing oil after draining, the system is not left clean because, while under optimum conditions the flushing oil may dissolve deposits, unless filtered out of the flushing oil during operation, at least a portion of the contaminants will again deposit out and remain in the system when the flushing oil is drained off.

It has heretofore been proposed to periodically couple an oil clarifier in a closed circuit with the lubricating system of an airplane engine and cyclicly pass the lubricating oil through the lubricating circuit and the clarifier to flush the system and at the same time reclaim the oil. It is found, however, that if the contaminants are first removed from the oil supply prior to its flushing circulation through the lubricating system, and the oil then circulated through the system and clarifier under controlled conditions of pressures and temperatures, the efficiency of the flushing operation may be greatly increased. It is known that heated oil has improved solvent properties and it has been also found that, if the oil flowing from the storage supply is heated immedi-

ately prior to its passage through the lubricating system the time for solution and removal of deposits from the system may be reduced.

This invention, therefore, consists in the method of reclaiming the oil supply and flushing the lubricating system of an internal combustion engine or other mechanism comprising initially removing contaminants from the entire lubricating oil supply, circulating the cleaned lubricating oil through the lubricating system to flush out contaminating deposits therefrom, and removing the flushed out contaminants from the oil.

The invention enables the oil to be circulated through the clarifying circuit and lubricating circuit at independent rates of flow and pressures in accordance with the operating requirements of said circuits.

The invention is applicable to reconditioning the lubricating system of an airplane engine having a hopper tank for the oil supply by withdrawing the oil from the hopper, passing it through a clarifier and returning the oil to the main tank in a cyclic flow to clarify the oil supply and remove deposits from both the hopper and main tank and then circulating the clean oil successively through the clarifier and the lubricating system to remove contaminating deposits from the system.

The invention also consists in providing apparatus for periodically reclaiming the lubricating oil supply and flushing the lubricating system of an internal combustion engine or other mechanism, said system including a storage tank for the oil supply, comprising a portable oil clarifier adapted to remove contaminants from oil circulating therethrough, conduit means for coupling the clarifier in a closed circuit with the storage tank, other conduit means for coupling the clarifier in a second closed circuit with the oil flow circuit of the lubricating system, and means for selectively circulating the lubricating oil supply through either of said circuits.

In order to make the invention more clearly understood, reference is made to the accompanying drawings which are for the purpose of illustrating only the preferred means of carrying the invention into practical effect.

In the drawings:

Figure 1 is a plan view of an airplane illustrating in operative position with respect thereto a portable conditioning unit which is coupled into the lubricating system of the engine of the airplane in accordance with this invention.

Figure 2 is a side elevational view of the portable oil clarifying unit illustrating diagrammatically the manner of coupling the unit into the lubricating system of an airplane engine.

Figure 3 is a sectional view taken substantially on the line 3—3 of Figure 2 illustrating in elevation the oil clarifier and certain of its cooperating elements.

Figure 4 is a fragmental plan view of the parts shown in Figure 3 with the cover of the clarifier enclosing shell removed.

Figure 5 is a transverse sectional view taken through the shut-off valves and cross-over conduits in the line connecting the clarifier with the engine.

Figure 6 is a longitudinal sectional view taken along the line 6—6 of Figure 5.

Figure 7 is a transverse sectional view of a coupling fixture designed to couple the clarifier connecting conduits into that portion of the oil passage of the engine normally occupied by the engine oil strainer.

Figure 8 is a transverse sectional view through the oil clarifier and its associated boiler.

Figure 9 is a horizontal sectional view taken along the line 9—9 of Figure 8.

Figure 10 is a horizontal sectional view taken substantially along the line 10—10 of Figure 8, parts being broken away to illustrate the fire box portion of the boiler.

Figure 11 is a transverse sectional view through one of the replaceable oil clarifying units.

Before describing the invention, reference is made first to Figure 2 of the drawings which illustrates diagrammatically the lubricating system of an airplane engine. Figure 2 shows a liquid cooled dry sump engine 1 which is provided with an oil pressure pump 2 and a scavenger pump 3. An oil supply tank 4 delivers oil from the bottom thereof through a feed line 5 to the input side of the pressure pump 2. The line 5 is provided with a Y-drain 6 normally closed by means of valve 7. The pressure pump 2 delivers the oil through a duct 8 into a strainer chamber 9 (Figure 7), through a strainer (not shown), and into an oil distribution manifold 10 from which the oil is distributed to the several lubrication points in the engine. The oil is returned from the engine to the top of the storage tank by means of the scavenger pump 3 through the return line 11 in which is positioned an oil cooler or radiator 12.

Often the oil storage tank of an airplane lubricating system is a hopper type tank such as shown in Figure 2, having a main storage reservoir 13 within which is a smaller reservoir or hopper 14. The upper end of the hopper 14 is in sealed connection with the top of the main storage tank and is adapted to receive oil from the scavenger pump 3 through the

oil return line 11. The hopper 14 communicates with the interior of the main storage tank through small orifices 15, and has a funnel shaped lower end which discharges into the oil feed line 5.

BASIC APPARATUS.

In order to reclaim the lubricating oil and at the same time thoroughly clean and flush such a lubricating system, there is employed a portable apparatus which may be periodically coupled into the system. A preferred type of such apparatus is illustrated in Figures 1 to 4 and consists essentially of an oil clarifying and circulating system designated generally as 16 and mounted on a mobile carriage designated generally as 17. The carriage 17 is preferably of a trailer truck type comprising a channel iron chassis frame 18 supported on a pair of rubber-tired wheels 19. The forward portion of the chassis frame 17 terminates in a draft bar 20 equipped with a tow ring 21 or other suitable coupling device by means of which it may be attached to a towing apparatus such as a jeep. Suspended from the forward end of the draft bar 20 by means of a jacking arrangement 22 is a small caster wheel 23. The jack 22 serves to raise the wheel 23 out of the way when the device is being towed or to lower the wheel into ground engaging position, as shown in Figure 2, to permit leveling of the apparatus and to assist in moving it to operative position with respect to the airplane. The adjustable caster wheel likewise facilitates hitching the apparatus to its tow car.

Mounted on the chassis frame 17 between the wheels 19 is an oil clarifier unit 24 to be described in detail later, and which consists essentially of an oil clarifier below which is positioned a steam generator or boiler for heating the clarifier. The clarifier is a closed type of large capacity through which oil is circulated under pressure and is provided with an input line 25 and an output line 26. The boiler and clarifier are enclosed in a shell spaced therefrom which serves both as a flue for the boiler and to insulate the clarifier. Heat is supplied for the boiler by means of a burner 27 preferably of a pressure gasoline type. This burner is suspended beneath the chassis frame and connected with the boiler by means of a flame duct 28.

Positioned forwardly of the clarifier unit 24, on a transverse shelf 29 secured to the side beams of the frame 17, is an oil circulating pump 30 adapted to be driven by suitable means, such as a belt drive 31, from a small gasoline motor 32 likewise supported on the shelf 29. Preferably the pump 30 has a capacity greater than the engine pressure pump 2. The motor 32 receives its fuel supply by gravity from an elevated gas tank 33. The delivery side of the pump 30 communicates with an air dome 34 and also through a discharge line 35, with the input line 25 of the clarifier. A by-pass line 36, controlled by a pressure relief valve 37, connects the delivery side of the pump with its input side to maintain the operating pressure of the pump at a predetermined maximum. A three-way valve 38 is positioned at the input side of the pump 30 while a second three-way valve 39 is positioned at the end of the discharge pipe 26 from the clarifier.

If desired, the motor and pump units may be enclosed in a suitable housing 40 (Figure 1) carried by a framework 41 supported on the chassis 17. This framework may also serve as a support for the gasoline tank 33.

In addition to the apparatus discussed above, the unit 16 also includes a gasoline supply tank 42 which may be conveniently attached to the outer surface of the clarifier unit 24 and is adapted to supply fuel for the burner 27. The fuel to the burner is supplied under air pressure created preferably by means of a suitable hand or foot operated air pump (not shown) but which is adapted during the operation of the unit to be connected to a valve controlled fitting 43 communicating with the upper portion of the tank through a vertical pipe 44. By means of this pump air may be supplied to the upper portion of the tank to force the fuel therefrom under pressure through a valve controlled feed line 45 to the burner 27.

Likewise attached to the clarifier unit 24 is a fresh oil storage tank 46 equipped with a filling neck 47. The tank 46 is adapted to supply fresh make up oil for the system through a pipe 48 leading to the input side of a hand operated pump 49 which discharges through a line 50 and a check valve 51 into the input line 25 of the clarifier. A suitable meter 52 may be provided in the line 51 for indicating the amount of new oil being introduced from the storage tank 46 to the system.

To provide convenient means for temporarily coupling the clarifier into the lubricating system, I employ flexible hose lines. One of these lines, the line 53, has one of its ends attached to the three-way valve 38 and its opposite end provided with a suitable coupling fixture 54 by means of which it may be attached to the drain valve 7 in the Y of the oil line 5. A second flexible hose line 55 has one of its ends connected with the three-way discharge valve 39 and its opposite end equipped with a connector 56 adapted to replace the regular filler cap of the storage tank 4 and by means of which the line 55

may be connected with the filler duct 57 of the oil storage tank.

When connected, as shown in Figure 2, with the three-way valves 38 and 39 adjusted to place the hose lines 53 and 55 in communication, respectively, with the input side of the pump 30 and the discharge line 26 of the clarifier, and with the oil pump 30 operating, it will be seen that oil will be withdrawn from the bottom of the storage tank, passed through the clarifier and returned to the storage tank. In the event that a hopper tank is provided in the system, the oil will be withdrawn from the bottom of the hopper, but instead of being reintroduced into the hopper as in the customary lubricating circulation, the oil, after passing through the clarifier, will be introduced into the main storage tank. As a result the clarified oil flows over both the hopper and main tank surfaces in a flushing operation which effectively removes all deposits from the tank. The flow through the storage tank in the orifices 15 produces sufficient turbulence to remove any deposits from the space below orifices 15.

The input three-way valve 38 likewise has attached thereto one end of a third hose line 58, the opposite end of which connects with a fitting designated generally as 59. Fitting 59 also connects with one end of a return hose line 60, the opposite end of which is attached to the three-way valve 39 controlling the discharge from the clarifier. The fitting 59 is preferably the same size and shape as the oil strainer or cuno of the engine and is designed to replace this regular strainer during the reconditioning operation and thereby provide a means for coupling the hose lines 58 and 60 into the lubricating system between the discharge side of the engine's pressure pump and the oil distribution manifold.

As best seen in Figure 7, the fitting 59 consists of a barrel portion 61 which is insertable in the strainer socket 9 after removal of the regular oil strainer from the engine. The barrel 61 is provided with an external flange 62 by means of which the fitting may be attached to the strainer mounting pad 63 by utilizing the regular strainer studs 64. The inner end of the barrel 61 is provided with a flexible gasket 65, the periphery of which closely engages the wall of the aperture 66 separating the oil strainer socket 9 from the oil distribution manifold 10. The gasket 65 is held in place against the end of the barrel 61 by means of a retaining disc 67 provided with a central aperture 68 which communicates with one end of a longitudinal passage 69 formed in the barrel 61. The opposite end of the passage 69 connects with a tapered socket 70 to which is connected by suitable means, such as a nipple 71 and union 72, the end of the hose line 60. Surrounding the passage 69 and separated therefrom is a passageway 73 communicating with the strainer chamber 9 through apertures 74. Passageway 73 connects with a tapered socket 75 to which is connected the end of the hose line 58 by means of a union 76 and nipple 77.

From the above it will be seen that oil withdrawn from the storage tank 4 by means of the engine's pressure pump is delivered through the duct 8 into the strainer chamber 9 from which it flows into the passageway 73 through apertures 74 and thence through hose 58 leading to the input side of the clarifier pump 30. Oil returning from the clarifier through the hose 60 passes through the central passageway 69 and into the distribution manifold 10 from which it flows to the several lubrication points of the engine to be returned to the storage tank by the scavenger pump 3.

During the above circulation, oil will be withdrawn from the storage tank 4 by the pressure pump 2 in amounts to satisfy the demands of the pump operating at normal engine speeds. This oil is forced under pressure through the clarifier by means of the clarifier pump 30 and returned to the engine. The amount of oil passed through the clarifier, however, usually exceeds the amount permitted to pass through the engine. To take care of this excess of oil and maintain proper oil pressures in the engine, a by-pass or cross-over arrangement, indicated generally as 78 and shown in detail in Figures 5 and 6, is provided between the hose lines 58 and 60 at a point substantially close to the fitting 59.

This by-pass arrangement consists essentially of a pair of parallel tubes 79 and 80 which are respectively interposed in the flexible pipe lines 58 and 60. The tubes 79 and 80 are each provided with a pair of flanged T's 81 and 82. The opposed T's 81 and 82, when joined together as shown in Figure 5, provide a pair of cross-over ducts or passageways 83 and 84, the passageway 83 connecting the tubes 79 and 80 at the clarifier end thereof and the passageway 84 connecting the tubes at the engine end of the tubes. Passageway 83 is provided with an apertured disc 85 clamped between the flanges of the adjoining T's to provide an orifice of fixed diameter in the passageway 83. A somewhat similar disc 86 is clamped between the flanges of the adjoining T's 82. The aperture in this disc, however, is provided with a spring loaded closure element 87

which constitutes a one-way pressure release valve in the passageway 84.

Positioned in each tube 79 and 80 between the connecting passageways 83 and 84 and adapted to open or block the lines 58 and 60, is a two-way plug valve, the rotating plugs 88 and 89 of which are axially aligned and have their stems 90 connected by an operating handle 91 by means of which the valves may be opened and closed together. The function of this valve control and cross-over arrangement will be best understood in the description of the operation of the apparatus to follow.

Although the lines 58 and 60 are shown coupled into the lubricating system at the delivery side of the pressure pump and this point of attachment is desirable in engines permitting it, engines of other designs may necessitate coupling the clarifier into other parts of their lubricating systems, and it is within the scope of this invention that the clarifier may be coupled in wherever convenient and operative.

OIL CLARIFIER.

The clarifier unit 24, as best shown in Figures 8, 9 and 10, consists of a reservoir 92 having a cylindrical side wall 93 closed at its lower end by a bottom plate 94. Parallel with the bottom 94, and spaced somewhat thereabove, is a partition wall 95 which divides the casing into an oil compartment 96 and a water and steam chamber 97 for the boiler, which is indicated generally as 98. The upper rim of the cylindrical wall 93 is externally flanged and is provided with a removable domed cover 99 adapted to close the upper end of the compartment 96. Between the cover 99 and the flanged edge of the cylindrical wall 93 is positioned a plate 100 provided on its upper surface with reinforcing fins. The plate 100 and the superposed domed cover 99 are attached to the flanged upper end of the cylindrcal wall 93 by means of bolts or studs 101, with a sealing gasket positioned between the rims of the cover 99 and the plate 100 and also between the rim of the plate 100 and the flange to effect an oil tight seal between the adjoining elements. The plate 100 divides the oil reservoir 96 into a filtering compartment 102 and a clean oil compartment 103 and additionally serves as a support for replaceable oil filtering cartridges, designated generally as 104, which are contained within the filtering compartment 102.

The input line 25, as will be seen, communicates with the interior of the compartment 102, while the discharge line 26 connects with a duct 105 extending into the clean oil compartment 103. A capped sludge drain line 106 is provided at the bottom of the filter compartment.

The type of replaceable filter cartridge which is preferred in connection with the present system is best shown in Figure 11 and consists essentially of a foraminous metal core 107 about which is spirally wrapped a strip of cellulose filtering material or wadding 108. Surrounding this spirally wound cellulosic filtering material is a molded tubular block 109 of a suitable absorbent material such as bonded fuller's earth or bauxite of sufficient porosity to permit the passage of oil radially therethrough. Surrounding the absorbent block 109 is a second spirally wound strip of cellulose filtering material 110 similar to the strip 108. A knitted fabric stocking member 111 may be positioned about the element, as shown in Figure 11, to maintain the wrappings in place and to serve also as an additional straining element for the filter. Secured to each end of the foraminous core 107 is an end plate 112 having a central aperture 113 concentrically secured with respect to which is a flexible gasket 114 of "Neoprene" or other suitable oil resistant material. Within the core 107 between the end plates 112 is a helically wound stiff wire reinforcing element 115. These replaceable cartridges are arranged within the filter compartment 102 in axially aligned pairs to substantially fill the compartment, as shown in Figures 8 and 9.

To axially align the pairs of replaceable cartridges and hold them in closely abutting end-to-end relationship and suspended from the supporting plate 100, a structure such as shown in Figure 11 is used. A circular bottom plate 116 engages the bottom face of the lower of the pair of filter elements and is secured, by means of a cap screw 117, to the lower end of the tubular barrel 118 positioned within the core of the lower cartridge. The upper end of the barrel 118 is provided with a centrally apertured screw threaded cap 119 through which passes a rod 120. The lower end of the rod 120, within the tubular barrel 118, is provided with a flange 121 between which and the screw threaded cap 119 is positioned a compression spring 122. The upper end of the rod 120 is welded or otherwise suitably secured centrally to a depending boss 123 concentrically formed on an upper circular plate 124 which engages the top face of the upper cartridge 104. A concentrically located boss 123^1 is also formed on the upper face of the plate 124. A plurality of oil discharge ducts 125 arranged within the circumferences of the bosses 123 and 123^1 pass through the plate 124 to communicate with the interior of the

filter core. Between the pair of cartridges is positioned an annular separator disc 126 having a central aperture 127.

The support plate 100 is provided with a plurality of openings 128 arranged to axially coincide with the desired position of the filter cartridges within the clarifier, and, when assembled, the top plate 124 of each cartridge assembly is positioned concentrically with one of these openings 128 by spigoting the bosses 123[1] within the openings and the cartridge assembly drawn up against the under surface of the support plate by a cap screw 129. The screw passes through a spider 130 positioned over the opening 128 and into a threaded aperture provided for the bolt in the boss 123 of the top plate. A sealing gasket 131 is positioned between the under surface of the support plate 100 and the upper surface of the top plate 124.

It will be noted from Figure 11 that the gaskets 114 adjacent the upper end of the top cartridge and the lower end of the bottom cartridge are in sealing engagement respectively with the boss 123 and the tubular barrel 118 to prevent leakage from the core 107 past these elements. The apertures in gaskets 114 at the adjoining ends of the cartridges, however, and the aperture 127 in the separator plate provide communication between the cores of the assembly. The compression spring 115 maintains a substantially close engagement between the filter cartridges and the end plates 116 and 124 and the separator plate 126 to prevent short circuiting of oil into the central cores.

The clarifier oil chamber 102, during operation, is completely filled with oil and, as the pump 30 delivers oil from the storage tank 4 into the clarifier, the oil is forced under pressure through the elements 110, 109 and 108 and into the central core 107. From here the oil discharges through the ducts 125, the openings 128 in the support plate and into the clean oil chamber 103 from which it discharges through the registering discharge lines 105 and 26. During the passage of the oil through the cartridges, its content of contaminating matter will be removed by the combined filtering action of the cellulose wadding elements 108 and 110 and the adsorbing action of the block 109. Since there is no communication between the compartments 102 and 103, except through the cartridges 104, all of the oil from the chamber 102 must first pass through the filter cartridges before being discharged from the clarifier and into the lubricating system of the engine, and as a consequence only oil which is clean both physically and chemically is passed to the engine for the flushing operation.

Provision is made for controlled bleeding of air from the clarifier unit by means of valved vent lines, as best shown in Figures 3 and 4. Communicating with the head of the oil compartment 103, through an elbow 132, is a pipe line 133 which extends to the periphery of the cover 99 and connects with a vertical pipe 134 by means of a union 135. The line 134 connects with the fresh oil storage tank 46 and has interposed therein a stop cock 136 and a sight glass 137. The system may be additionally bled through a pipe line 138 which connects the air dome 34 of the clarifier pump 30 also with the fresh oil storage tank 46. As shown, this line 138 is connected with the line 134 between the cock 136 and the tank and is controlled by means of a stop cock 139.

Suitable oil pressure gauges may be provided at the input and output sides of the clarifier to indicate operating oil pressures and a temperature gauge may also be provided. None of these gauges are shown but they may be of standard types connected in conventional manner.

CLARIFIER HEATING UNIT.

As mentioned above, the oil in the clarifier is heated. This is highly important for several reasons: First, the solvent property of the oil improves with rise in temperature and, as a consequence, the redissolving and removal of deposits from the contaminated lubrication system is better accomplished with hot oil. Secondly, if the oil supply of the clarifier is raised to the operating temperature of the oil supply of the engine, there will be no transfer of oil from one to the other due to thermal expansion or contraction. Also, when the oil is heated, flow resistance through the clarifier is reduced and proper oil pressures in the engine are maintained. The provision of means for heating the oil in the clarifier also readily adapts the unit for supplying hot oil for airplanes in frigid climates.

To heat the oil in the clarifier, it is preferred to employ a water tube steam generator or boiler constructed as a unitary part of the clarifier and arranged below the oil chamber 102. As shown in Figures 8, 9 and 10, the boiler consists essentially of the water and steam chamber 97 occupying the space in the lower portion of the clarifier shell between the bottom plate 94 and the partition plate 95. Below the chamber 97 is a heating chamber 140 enclosed in a housing 141 which communicates with the burner 27 through the flame duct 28. A series of water tubes 142 connect at one of their ends with the chamber 97, extend down into the heating chamber 140, and connect at their opposite ends with a header 143. The header

143 is arcuate in shape, closed at one end by a cap 144, and has its opposite end extending through the wall of the housing 141 and connected with a vertical filling pipe 145 adapted normally to be closed by means of a valve 146 (Fig. 3). The header 143 likewise communicates with the steam chamber 97 through vertical water tubes 147. For determining the water level in the chamber 97, a suitable valve controlled liquid level or sight gauge 148 (Fig. 3) is provided, preferably communicating with the filling pipe 145. The chamber 97 and water tubes may be drained by means of a drain cock 149 at the lower end of the sight gauge. A steam pressure gauge (not shown) may also be provided for the boiler.

The housing member 141 is of a somewhat larger diameter than the clarifier shell, is open at its upper end, and connects with a cylindrical shell 150. This shell is also slightly larger than the clarifier wall and is held in spaced relation thereto by supporting strips 151. The upper end of the shell 150 has detachably joined thereto a cover 152 spaced above the clarifier top 99 and is provided with a central opening 153. This structure functions as a flue for the boiler and, since it completely surrounds the clarifier, serves also to effectively insulate the clarifier. If desired, flame baffles 154 may be provided in the heating chamber 140 to evenly distribute heat from the burners over the water tubes. Baffles or fins 155 may also be provided in the steam chamber 97.

To insure rapid transfer of heat to the oil in the chamber 102, a series of steam tubes 156 are brazed into apertures provided therefor in the partition plate 95 and extend upwardly into the oil chamber 96 between the filter cartridges 104, as illustrated in Figures 8 and 9. These tubes are closed at their upper end and are provided with longitudinal external fins 157. Extending up into each of the tubes 156 to approximately the closed upper end, is a vent pipe 158, preferably curved as shown in Figure 8, to engage the inner surface of the steam tube. The vent lines connect at their lower ends to a ring-like header 159 provided with a bleed line 160 normally closed by means of a stop cock 161.

OPERATION.

When initially putting the apparatus above described into service, the clarifier is first filled with oil. To fill the clarifier the suction hose 53 is inserted in a container of new lubricating oil, the three-way valve 38 is adjusted to place the hose line 53 in communication with the inlet side of the pump and the pump is put in operation by starting its driving motor 32. The three-way discharge valve 39 and air bleed valves 136 and 139 are kept closed until an 18 to 20 pound oil pressure is obtained in the clarifier oil chamber 96. After this pressure has been obtained, the valve 39 is then slightly cracked to place the discharge side of the clarifier in communication with the discharge hose line 55 in order to bleed air from the head space of the clarifier. The valve 39 is continuously adjusted during this stage to maintain an operating pressure of the oil of between 10 and 20 pounds. The purpose of maintaining this oil pressure during the filling operation is to force the oil into the filter cartridges and insure elimination of all air from them. When the oil starts to flow from the discharge end of the hose line 55, both of the three-way valves 38 and 39 are closed and the pump is stopped.

After the oil chamber 96 has been filled, the next operation is to fill the boiler and prepare to heat the clarifier to an operating temperature. Water is admitted into the chamber 97 through the filling line 145 until the proper amount of introduced water is registered in the sight gauge 148. The shut-off valve 146 is then closed. The burner fuel tank 42 is next filled about two-thirds full with gasoline to leave a head space therein which is pressurized to about 25 to 30 pounds by means of the auxiliary pump above described. The burner 27 is then preheated by means of a gasoline blow torch or other suitable means, after which the fuel line 45 is opened and burner needle valve 162 adjusted to admit gasoline to the burner. Heat from the burner will generate steam in the boiler which rises in the steam tubes 156 to heat the oil in the chamber 96. During the initial steam generation, the valve 161, controlling the vent lines 158, is open to bleed all air out of the steam tubes. When only steam is flowing from the line 160, the valve 161 is closed. A gasoline pressure of approximately 38 or 40 pounds is maintained until the temperature of the oil has reached approximately 180° F. When the oil has reached this temperature, the steam pressure in the boiler should be approximately 8 to 10 pounds and the gasoline pressure in the tank 42 may then be lowered and the needle valve 162 adjusted to maintain this steam pressure.

When starting to heat the clarifier, both of the three-way oil circuit valves 38 and 39 should be closed. The bleed valves 136 and 139 are likewise both closed. As the clarifier heats, the oil expands and pressure develops inside the clarifier chamber 92. When this pressure reaches approximately 10 pounds, the valve 136 control-

ling the bleed line from the top of the clarifier is opened. This bleed line exhausts into the head space of the fresh oil tank 46 and, when as noted in the sight glass 137, a solid stream of oil is flowing through the line 135, the valve 136 is closed. As pressure continues to rise in the clarifier, air is bled from the air dome 34 of the pump through the bleed line 138, any oil being discharged through this line likewise flowing into the fresh oil tank. Air entering the tank 46 will be vented therefrom through the regular tank vent (not shown). After the clarifier has been completely bled of all air, the bleed lines are closed.

After the above operations have been carried out, the next step in preconditioning the apparatus is to circulate the heated oil through the hose lines 58 and 60 to insure absolute cleanliness of these hoses and the clean oil side of the clarifier, to equalize temperatures in the clarifier and hose lines, and to insure complete air elimination from the entire clarifying system. To circulate oil through the lines 58 and 60, the crossover valves 88 and 89 are turned to closed position and the three-way discharge valves 38 and 39 are turned to place the line 60 in communication with the discharge side of the clarifier and the line 58 in communication with the input side of the pump 30, and the pump 30 is operated at normal operating speed. This effects the circulation of the oil from the clarifier through the line 60, the cross-over conduit 83, and back to the input side of the pump 30. Since the lines 58 and 60 are empty at the start of this operation, additional oil must be added to fill the system. This is effected by means of the hand pump 49 which will deliver oil from the new oil tank 46 into the input line 25 of the clarifier. Fresh oil is admitted into the system until pressure in the clarifier again reaches approximately 10 pounds. The above set forth bleeding operation is then repeated to first bleed air from the top of the clarifier and then from the air dome in the pump. This precirculation is continued for about 20 to 30 minutes to thoroughly clean the clean oil chamber 103 and the circulating lines 58 and 60. It is preferable to carry out this circulating operation also at intervals between the servicing of airplanes as the circulation and multiple filtering of the oil will maintain the oil at an optimum condition and greatly increase the effectiveness of the unit.

The apparatus is now in condition to service the lubricating system of an airplane and the unit is placed in a convenient position with respect to the airplane as shown in Figure 1, preferably at the trailing edge of the wing but out of the air wash from the propellers. The hose line 53 is connected to the Y-drain valve 7 of the lubricating system and the fitting 56 on the end of the line 55 is screwed onto the filling neck 57 of the oil supply tank to replace the filler cap of the tank. The oil strainer of the engine is removed and the coupling fitting 59 carrying the ends of the hoses 58 and 60 is inserted into the strained chamber and secured to the strainer pad of the engine.

The first servicing operation is on the supply tank 4 and the feed line 5. The Y-drain valve 7 is opened and the three-way valves 38 and 39 are adjusted so that oil will circulate through the lines 53 and 55. Pump 30 is put in operation and oil is drawn by the pump from the bottom of the tank 4 through the line 5 and the hose 53. The pump 30 discharges the withdrawn oil under pressure into the oil chamber 102, through the filter cartridges 104 and into the clean oil chamber 103. From thence it flows through the outlet lines 105 and 26, the three-way valve 39 and hose 55, back into the tank 4. The boiler is operating and the oil from the tank 4 is heated in its passage through the clarifier. This circulation is maintained preferably for a minimum of five minutes at an oil temperature of approximately 185° F. The Y-drain valve 7 is then closed and the three-way valves 38 and 39 adjusted to permit circulation through the lines 58 and 60 with the valves 88 and 89 in the cross-over fixture 78 closed. At this time, if desired, the lines 53 and 55 may be disconnected, the hoses 53 and 55 stowed, and the filler cap replaced on the tank 4.

The oil in the clarifier is now recirculating through the lines 58 and 60 by way of the cross-over conduit 83. Valves 88 and 89 in the cross-over fitting 78 are then opened and the engine started and operated at a speed of about 1200 R.P.M. Clean oil from the storage tank 4 will then be withdrawn from the tank by the pressure pump 2 of the engine and delivered through the duct 8 into the strainer chamber 9, thence through the passageway 73, the hose line 58 to the input side of the pump 30. Pump 30 forces the oil under pressure through the clarifier filter units 104, into the clean oil compartment 103, thence through the discharge lines 105 and 26, the three-way valve 39, hose 60, passageway 69 of the fitting 59 and into the oil manifold 10 from which it flows to the several lubrication points in the engine. The scavenger pump 3 then returns the oil to the storage tank 4 through the line 11 and oil radiator 12. In this circulating flow, deposits in the

engine, oil passages and the oil radiator are dissolved by the clean heated oil and continuously filtered out of the oil in its passage through the clarifier units 104. The normal time for continuing this flushing operation is a minimum of 15 minutes and a maximum of 18 minutes at a recommended oil temperature of approximately 185° F. and an engine oil pressure of from 50 to 70 pounds per square inch.

The above flushing time of 18 minutes is given as a maximum when servicing engines in use under normal conditions. Under certain other conditions, however,—for instance, after long periods without servicing or when servicing new engines—the flushing time may be considerably extended beyond 18 minutes, the time depending entirely upon the amount of contamination within the lubricating system. In connection with servicing new engines when first installed or " run-in ", the present system of flushing has been found particularly efficacious in completely eliminating all traces of the protective material, known to aviation mechanics as " embalming fluid ", from the engine before it is put in service.

As above set forth, the pressure pump of the engine is withdrawing oil from the storage tank in amounts to satisfy the demand of the pressure pump operating at the specified engine speed. Since, as stated, the pump 30 has a greater capacity than the engine pressure pump, the amount of oil discharging from the clarifier is in excess of the amount desired to pass through the engine at optimum pressures. The balance of oil, in excess of that which passes through the engine, will be by-passed through the fixed orifice 85 in the cross-over conduit 83 and recirculated through the clarifier. This by-passing and recirculation not only assures optimum operating pressure in the engine but also effects the recirculation of a good portion of the oil through the clarifier and thereby effects a more efficient cleaning operation for the oil. Should the engine be put into operation with the cross-over valves 88 and 89 closed, or should the filter cartridges 104 in the clarifier become so clogged as to preclude the passage of sufficient oil to satisfy the demands of the engine, the valve 87 in the cross-over conduit 84 will function as a safety valve and assure that an adequate supply will by-pass the clarifier to satisfy the requirements of the engine.

The large capacity clarifier, together with the high capacity circulating pump 30, functions importantly in the servicing operation. First, an adequate supply of clarified oil is always available to meet all operating requirements of whatever type engine is being serviced. Also it assures that all of the oil delivered to the engine is thoroughly clarified not only by its passage through the clarifying cartridges at a lower pressure than would be possible with a small clarifier through which oil, of necessity, would have to pass at a greater rate to meet engine requirements, but in fact a portion of the oil is passed through the clarifying cartridges several times before being delivered to the engine.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is :—

1. A method of reclaiming the oil supply and flushing the lubricating system of an internal combustion engine or other mechanism comprising initially removing contaminants from the entire lubricating oil supply, circulating the cleaned lubricating oil through the lubricating system to flush out contaminating deposits therefrom, and removing the flushed out contaminants from the oil.

2. A method according to claim 1 comprising heating the initially cleaned oil before circulating the same through the lubricating system.

3. A method according to claim 1 or 2 wherein the circulation of the initially cleaned lubricating oil is effected in a cyclic flow through a filtering material and an adsorbent material in closed circuit with the lubricating system.

4. A method according to claims 2 and 3 comprising initially circulating the oil supply in a cyclic flow successively through a heating zone and a clarifying zone in closed circuit with the oil supply, and then circulating the oil in a cyclic flow through the heating zone and clarifying zone in a closed circuit with the lubricating system while continuously removing flushed out contaminants from the circulating oil.

5. A method according to any of claims 1—4 employing an oil storage tank in the lubricating system, comprising first withdrawing oil from said tank, passing the withdrawn oil through the clarifying zone, and returning the same directly to the tank in a recirculating flow to remove contaminants from the oil and tank, then withdrawing oil from the tank, passing the withdrawn oil through the clarifying zone, and returning the same to the tank through the lubricating system in a recirculating flow to remove contaminants from said lubricating system.

6. A method according to claim 5 comprising operating the engine to withdraw oil from the storage tank, the returned oil being in amounts to satisfy the lubricating

requirements of the system, and recirculating the withdrawn oil in excess of such amounts through the clarifying zone.

7. A method according to any of claims 1—6 for reclaiming the lubricating oil supply of an airplane engine having a hopper tank for holding said oil supply, comprising withdrawing oil from the hopper portion of the tank, clarifying the oil, and returning the clarified oil to the main storage portion of the tank in a recirculating flow of the oil whereby contaminating deposits are removed from the interior surfaces of said hopper tank.

8. An apparatus for periodically reclaiming the lubricating oil supply and flushing the lubricating system of an internal combustion engine or other mechanism, said system including a storage tank for the oil supply, comprising a portable oil clarifier adapted to remove contaminants from oil circulating therethrough, conduit means for coupling the clarifier in a closed circuit with the storage tank, other conduit means for coupling the clarifier in a second closed circuit with the oil flow circuit of the lubricating system, and means for selectively circulating the lubricating oil supply through either of said circuits.

9. An apparatus according to claim 8 comprising heat exchanger means associated with the clarifier for raising the temperature of the oil.

10. An apparatus according to claim 8 or 9 comprising also a tank adapted to contain fresh oil, and means including a pump for delivering fresh oil from the tank into the clarifier.

11. An apparatus according to claim 8 or 9 for periodically reclaiming the lubricating oil supply of an airplane engine having a hopper tank for the oil supply, wherein the oil clarifier can be coupled in a closed circuit between the hopper and the main storage reservoir of said hopper tank.

12. An apparatus according to claim 11 comprising additional conduit means for coupling the clarifier in a second closed circuit with the lubricating system, the lubricating oil supply being recirculable in either of the closed circuits.

13. An apparatus according to any of claims 8—12 comprising by-pass means associated with the selective circulation conduit means for recirculating directly through the clarifier a portion of the oil flowing in the second closed circuit.

14. An apparatus according to any of claims 8—13 for use in a lubricating system having a normal flow circuit in which the oil is withdrawn from the oil supply tank to lubrication points of the engine and returned to the tank, wherein the portable clarifier has an inlet and outlet for the circulating oil communicating with a pair of conduits for interposing the clarifier in the said normal flow circuit, and conduit means interconnecting said pair of conduits to permit circulation of oil through the clarifier and normal flow circuit of the lubricating system independently one from the other.

15. An apparatus according to claim 14 comprising an oil by-passing arrangement associated with the conduits to permit independent circulation of oil through the clarifier and lubricating flow circuit, said arrangement including a pair of cross-over passageways interconnecting the pair of conduits and valve means in each of said pair of conduits between the cross-over passageways.

16. An apparatus according to claim 15 wherein the lubricating oil circulates under pressure through the closed flow circuit and oil clarifier and wherein the valve means in each of the pair of conduits is a two-way valve arranged to permit a circulation of oil through the clarifier independently of the circulation through the lubrication circuit, an orifice being provided in one of said passageways for controlling flow of oil therethrough, a second passageway interconnecting the said conduits between the valves and the lubricating flow circuit to permit circulation of oil through said flow circuit with the valves closed, and or normally closed spring loaded valve being provided in the last named passageway for inhibiting oil flow therethrough when said valves are open.

17. An apparatus according to claim 16 comprising means under single manual control for actuating the two-way valves.

18. An apparatus according to any of claims 8—17 comprising an enclosed casing having a partition therein dividing the casing into an oil clarifying chamber and a steam generating chamber from which a plurality of steam tubes, each having a vent, extend into the clarifying chamber, and comprising a header communicating with the vent tubes and valves for venting the header.

19. An apparatus according to claim 18 having radiating fins on the steam tubes.

20. An apparatus according to claim 18 or 19 comprising a heating chamber associated with the steam generating chamber, and a flue for the heating chamber, said flue surrounding the oil clarifying chamber.

21. An apparatus according to any of claims 8—20 wherein the oil clarifier includes an enclosed chamber containing means for removing contaminants from oil in the passage of said oil through the

chamber, a tank serving as a reservoir for supplemental lubricating oil, and a valve controlled vent line connecting the top of the clarifier chamber with the top of the fresh oil tank.

22. An apparatus according to claim 21 wherein an oil conduit connects the tank with the clarifier chamber, and a pump or circulating means is associated with the oil conduit for displacing oil from said tank into the chamber.

23. An apparatus according to claim 22 comprising an air dome communicating with the delivery side of the pump, the valve controlled vent line connecting the air dome with the fresh oil tank.

24. An apparatus according to any of claims 18—23 in which the enclosed casing is cylindrical with a vertical longitudinal axis and has a horizontal partition wall therein dividing the casing into a chamber to receive oil to be clarified and a chamber to receive the clarified oil, a plurality of tubular filter elements within the first named chamber with their axes parallel with the axis of the casing, said elements being suspended from the partition wall, with the upper end of the tubular filter element in sealing engagement with the partition wall, conduits connecting the interiors of said tubular elements with the clarified oil chamber, and closures for the lower ends of the tubular filter elements.

25. Apparatus according to claim 24 wherein the horizontal partition wall has an aperture therethrough and a tubular filter element is axially aligned with said aperture, and wherein said apparatus comprises a top plate interposed between the upper end of the filter element and the under face of said wall, a passage in the plate registering with the interior of the tubular filter element and said aperture, a bottom plate engaging the lower end of the filter element, tensioning means passing axially through the filter element and interconnecting said plates, and means detachably securing the top plate to the under side of the partition wall.

26. Apparatus according to claim 25 wherein the detachable securing means includes a spider element engaging the upper face of the partition wall and overlying the aperture, and screw means connecting the spider with the top plate for detachably securing the top plate to the partition wall.

27. Apparatus according to claim 25 or 26 wherein the tensioning means include a telescoping rod member extending axially through the tubular filter element and interconnecting said plates and spring means serving to contact said telescoping member to thereby effectively clamp the filter element between the plates.

28. An apparatus according to any of claims 18—23 in which the enclosing casing is cylindrical with a vertical longitudinal axis, and has a horizontal partition wall therein dividing the casing into a chamber to receive oil to be clarified and a chamber to receive the clarified oil, said wall having an aperture therethrough, a tubular filter element within the first named chamber and axially aligned with the aperture wherein the top plate interposed between the upper end of the filter element and the under face of the partition wall has a boss thereon projecting axially into the tubular filter element, spring means connecting the boss and the tubular member for urging the plates together to effectively clamp the filter element therebetween, and sealing means being interposed respectively between the inner wall of the filter element and boss and between said inner wall and tubular member.

29. The method of reclaiming the oil supply and flushing the lubricating system of an internal combustion engine or other mechanism substantially as hereinbefore described.

30. Apparatus for periodically reclaiming the lubricating oil supply and flushing the lubricating system of an internal combustion engine or other mechanism substantially as hereinbefore described and substantially as shown on the accompanying drawings.

Dated this 16th day of February, 1945.

BRIGGS CLARIFIER COMPANY,
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111/112, Hatton Garden, London, E.C.1,
Chartered Patent Agents.

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589,882 COMPLETE SPECIFICATION

SHEET 1

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FIG. 1.

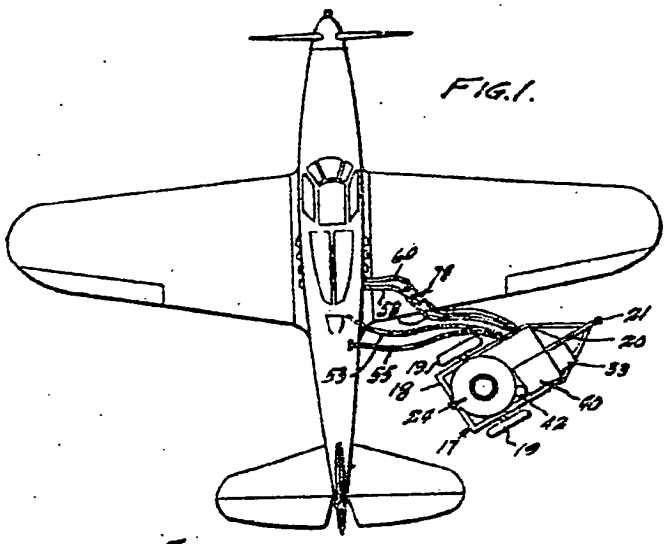


FIG. 2.

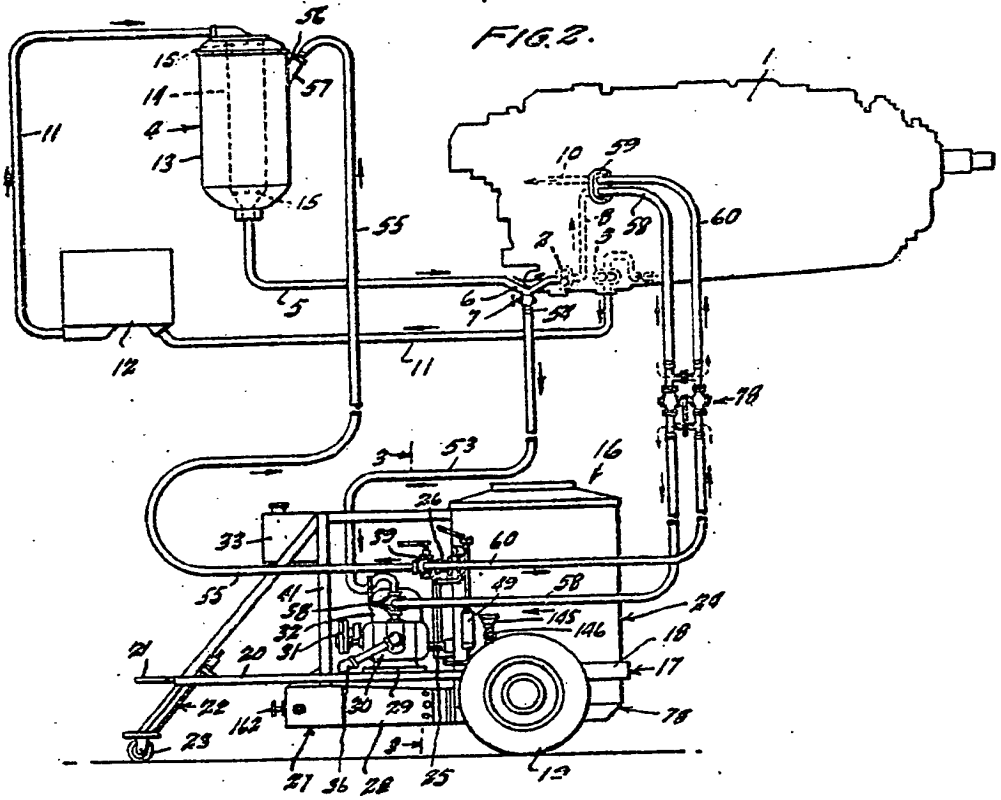
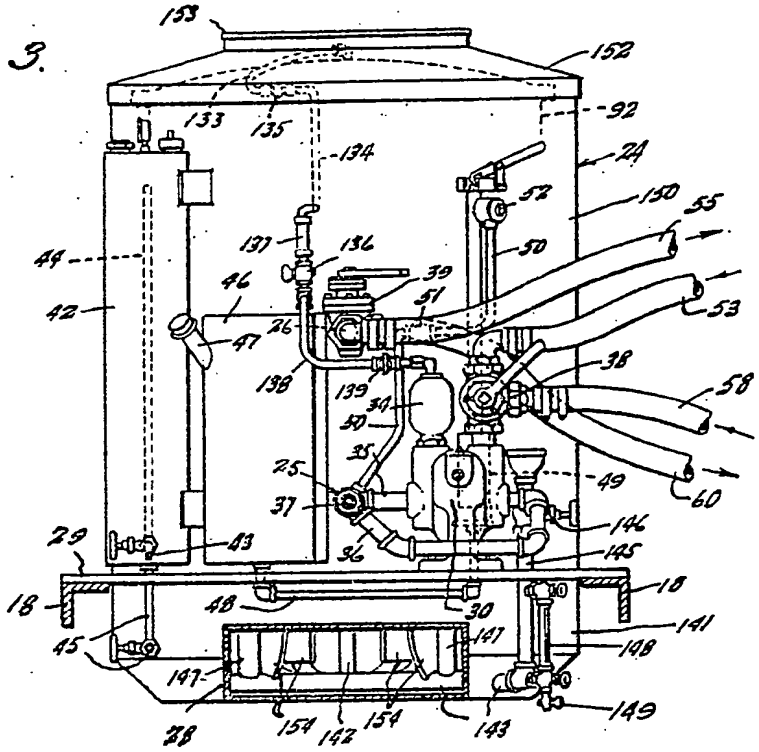


FIG. 3.



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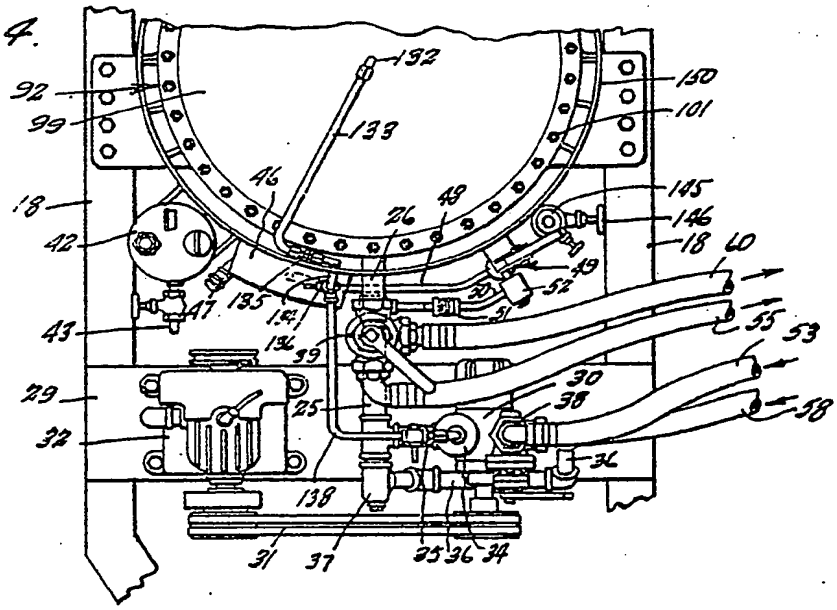


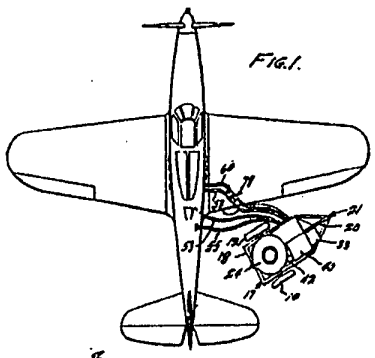
589,882 COMPLETE SPECIFICATION

6 SHEETS

SHEET 1

SHEET 2

FIG. 1.



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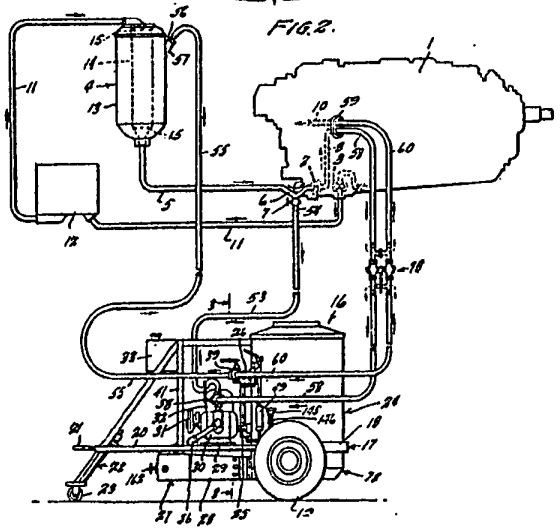

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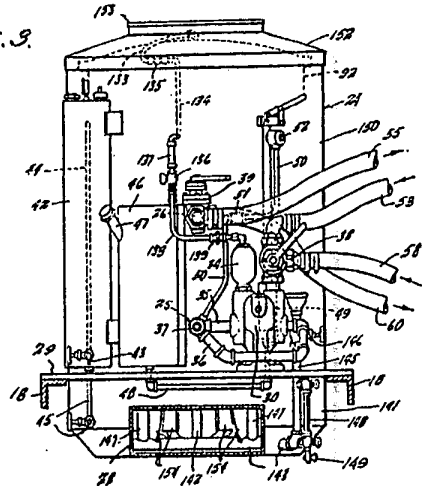

FIG. 4.

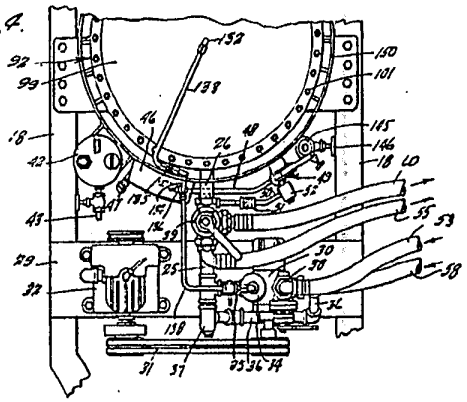

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FIG.5.

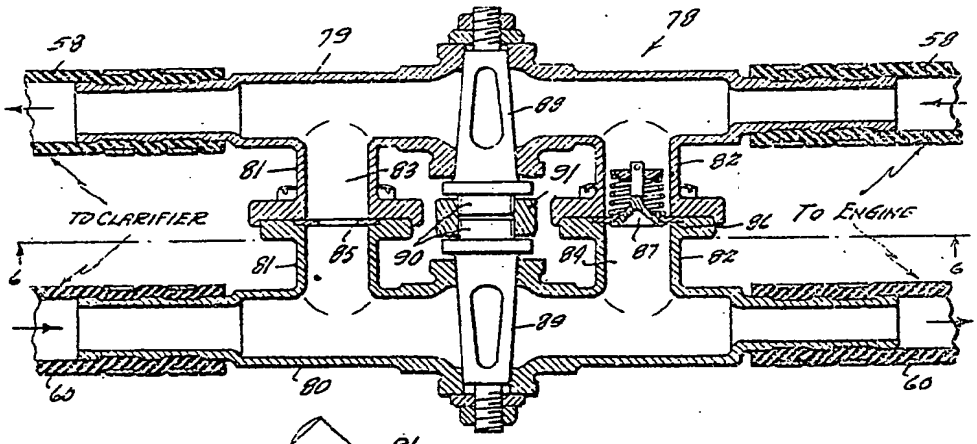


FIG.6.

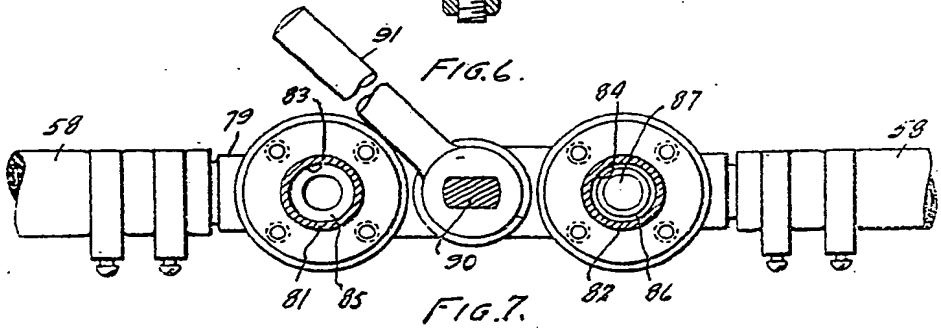
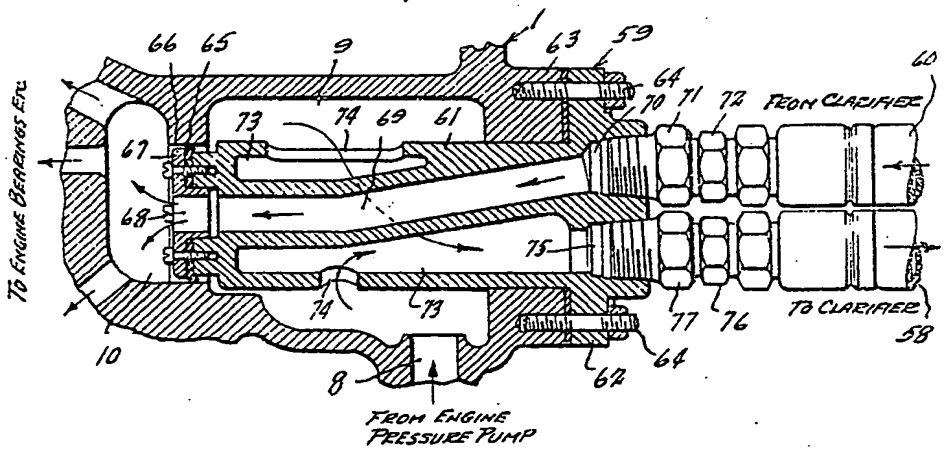
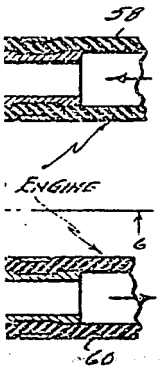
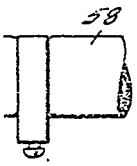


FIG.7.







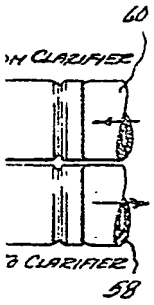
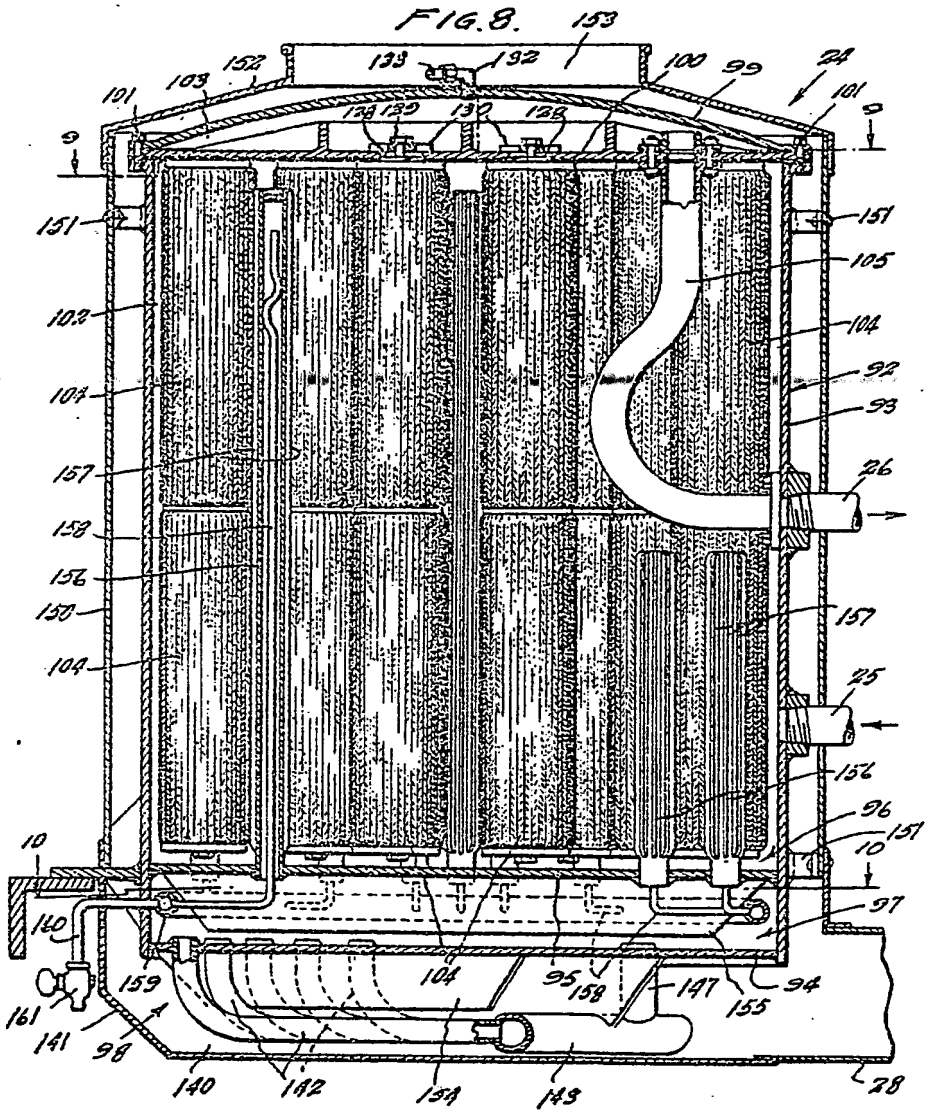


FIG. 8.



589,882 COMPLETE SPECIFICATION

6 SHEETS

SHEET 3

SHEET 4

FIG. 5.

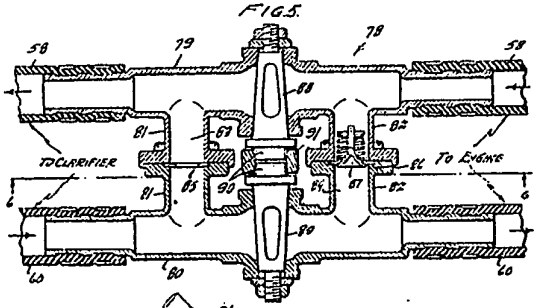


FIG. 6.

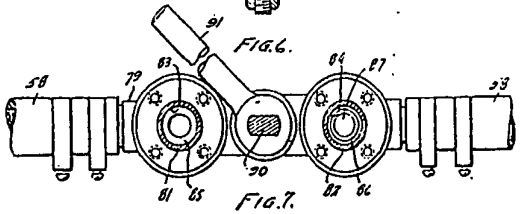


FIG. 7.

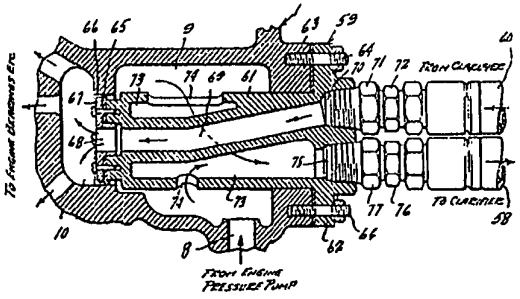


FIG. 8.

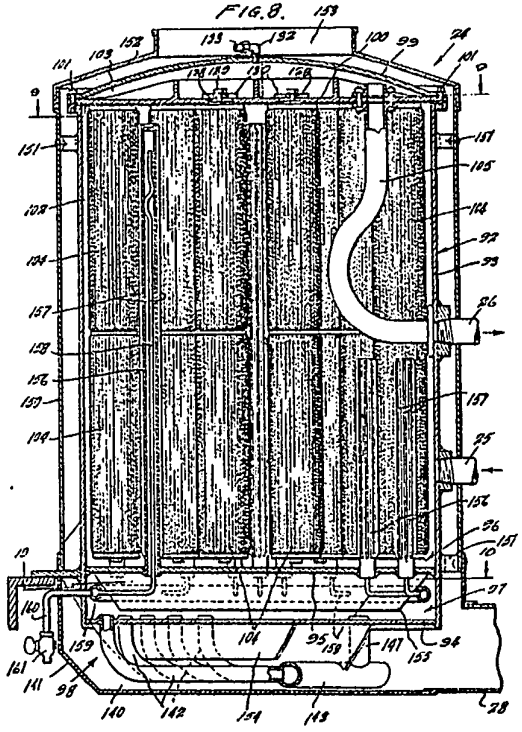


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FIG. 9.

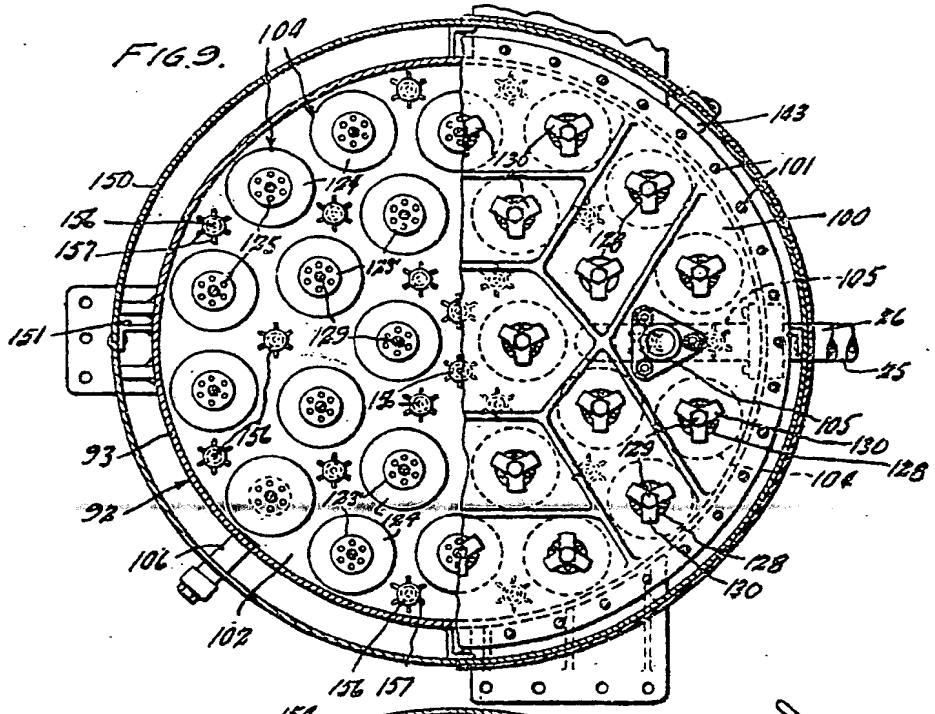
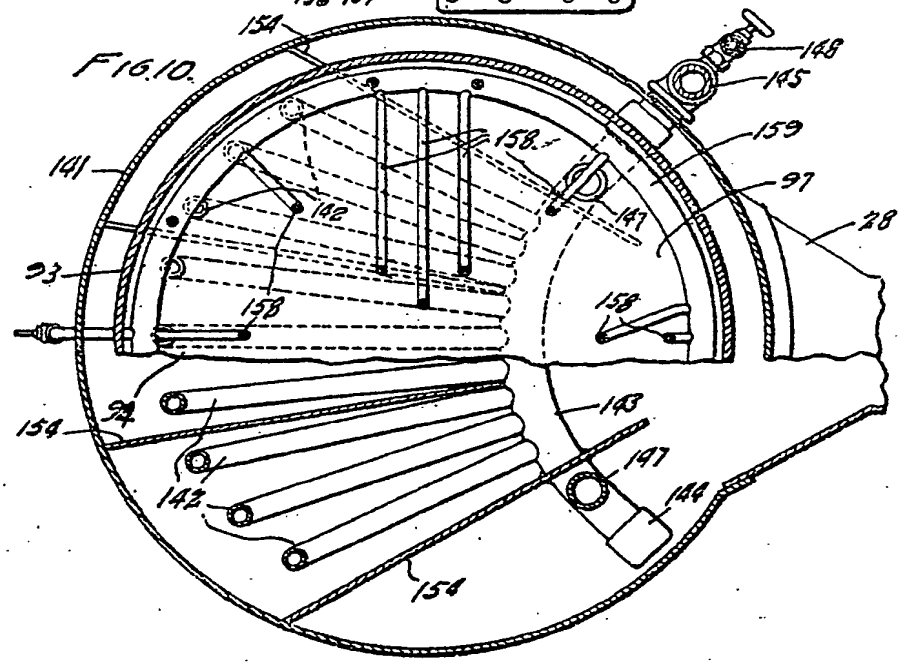


FIG. 10.



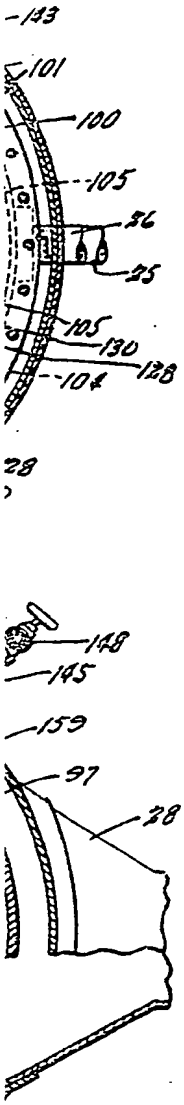
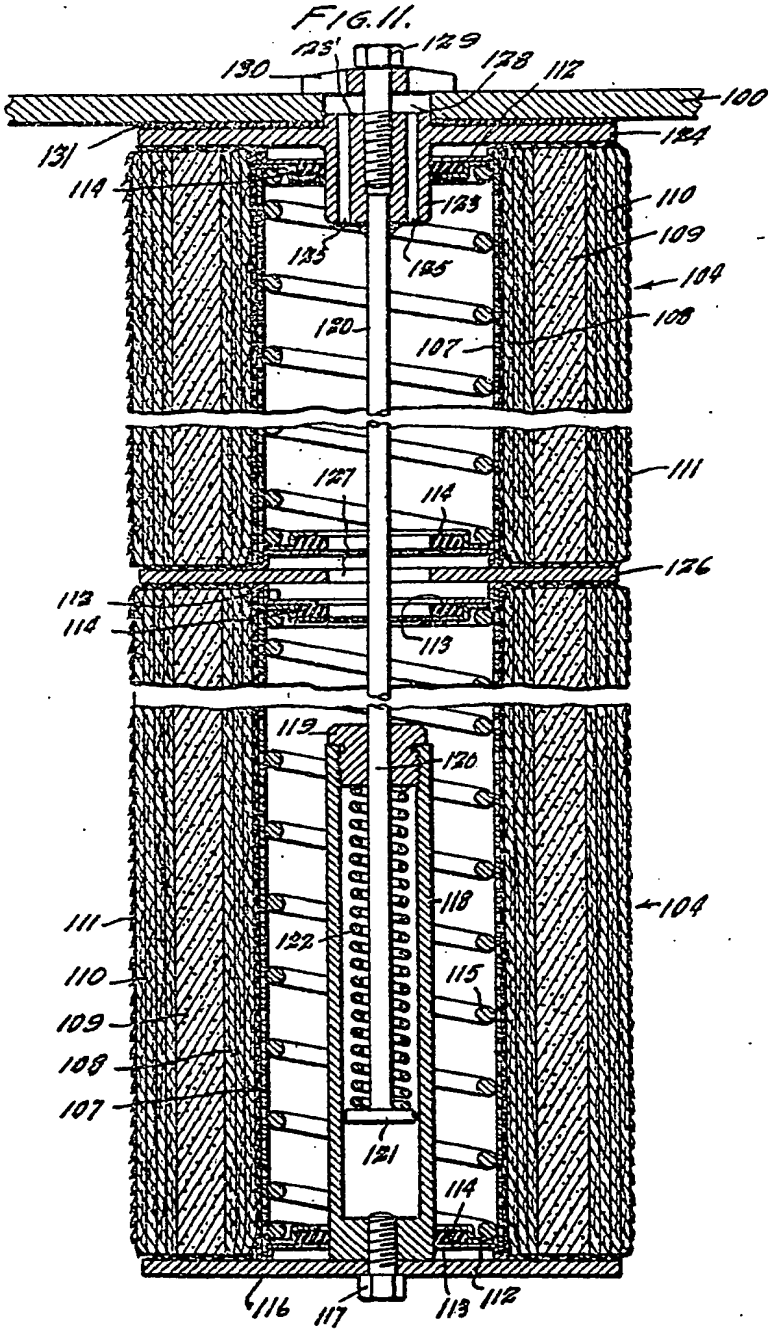


FIG. 11.



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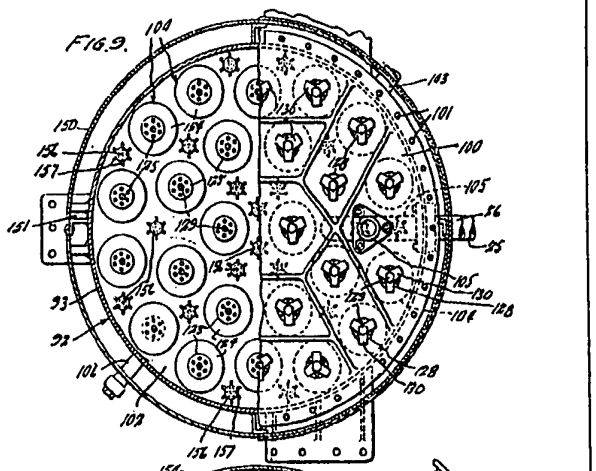
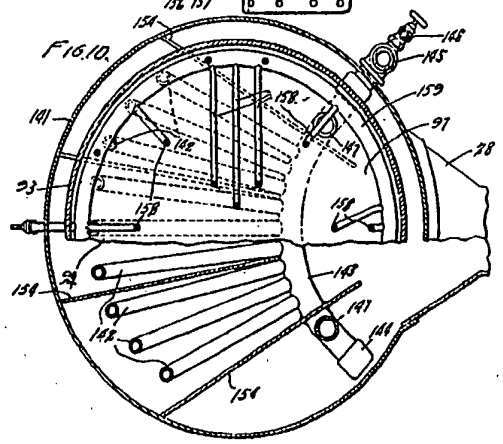
6 SHEETS

SHEET 5





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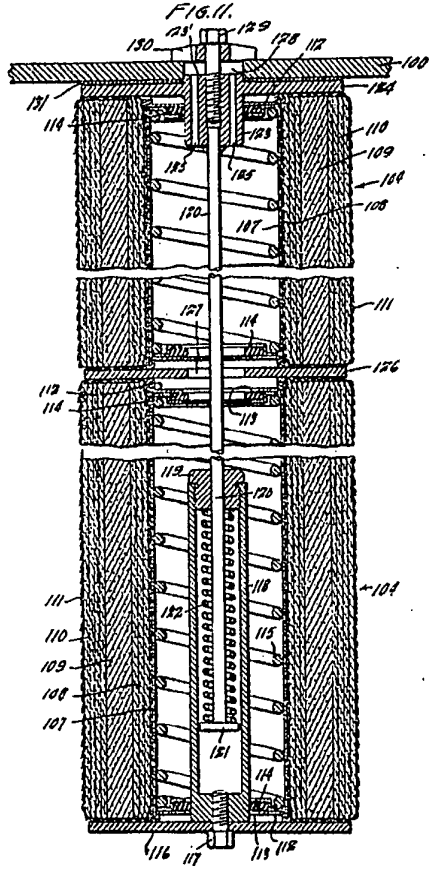
SHEET 6



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589,862 COMPLETE SPECIFICATION

SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

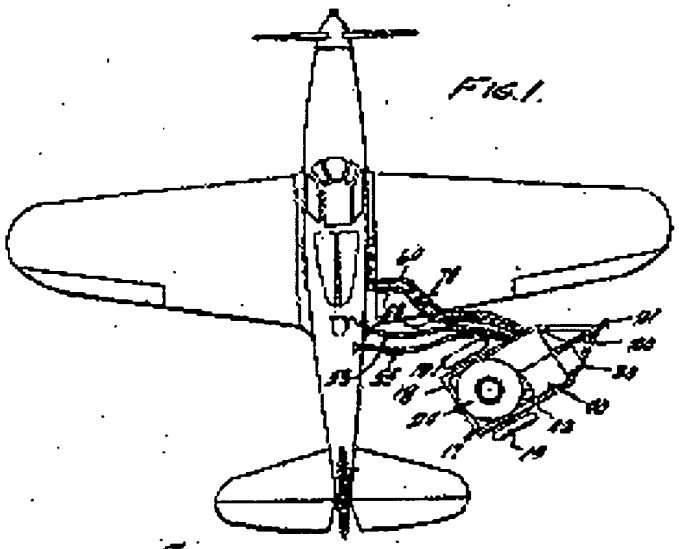


FIG. 2.

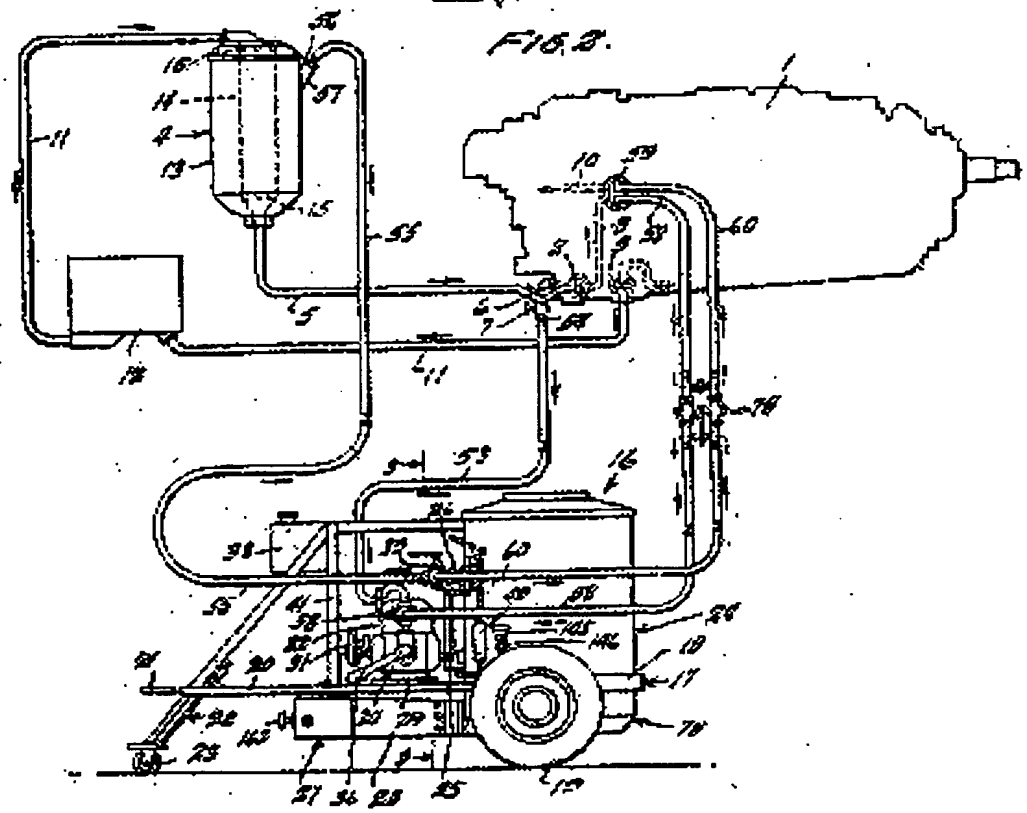
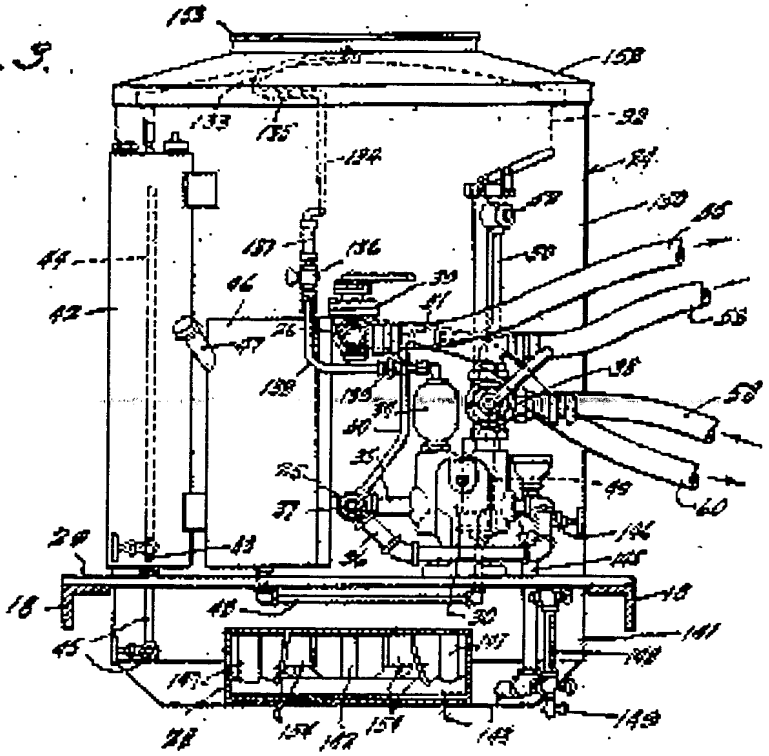


FIG. 3.



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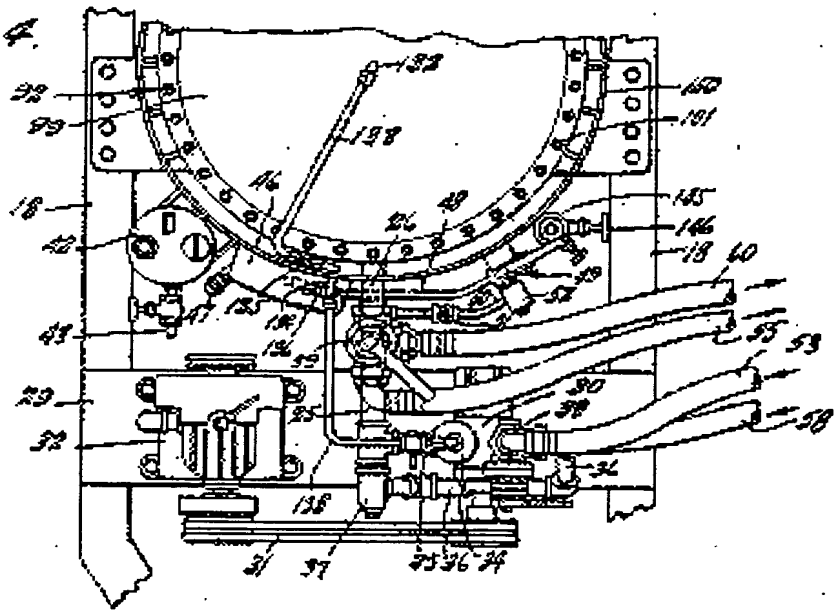

569,882 COMPLETE SPECIFICATION

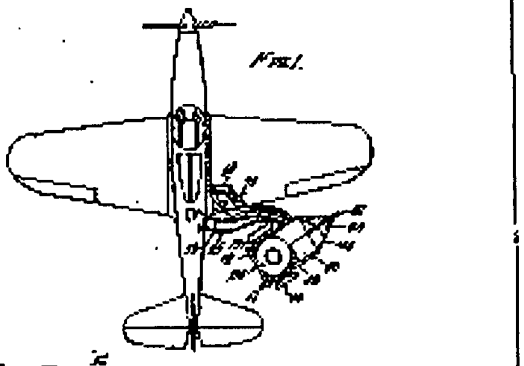

FIG. 1.

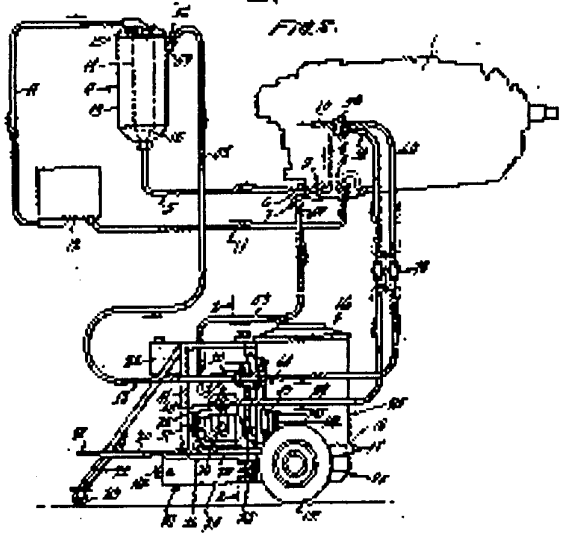

FIG. 3.

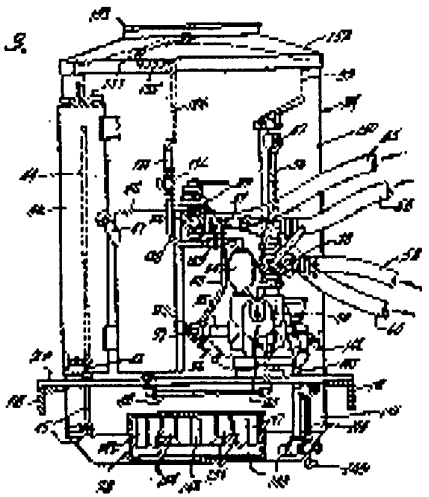

FIG. 2.

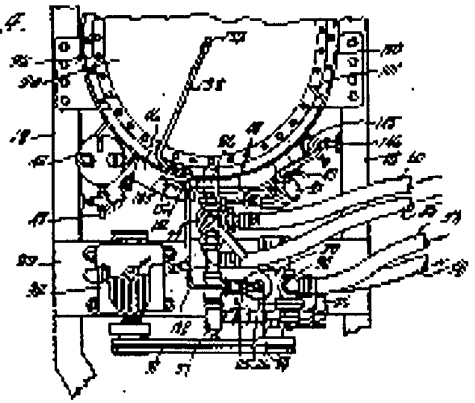

FIG. 4.

589,882 COMPLETE SPECIFICATION

SHEET 3

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FIG. 5.

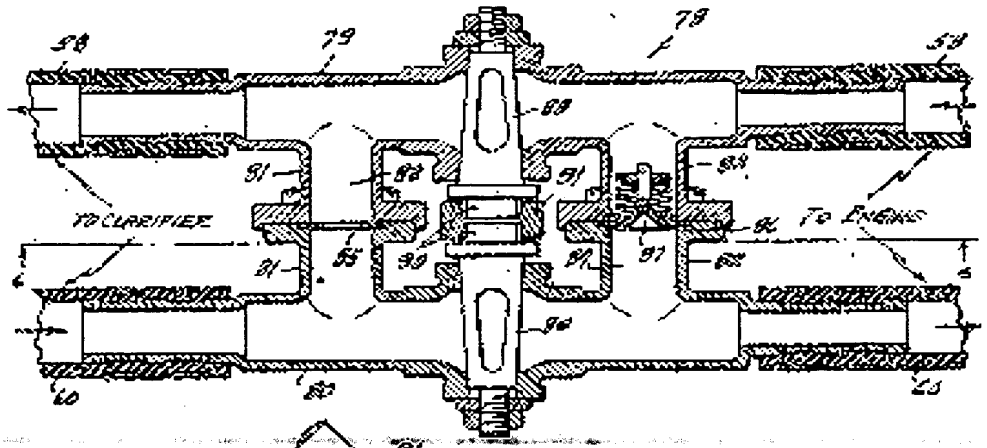


FIG. 6.

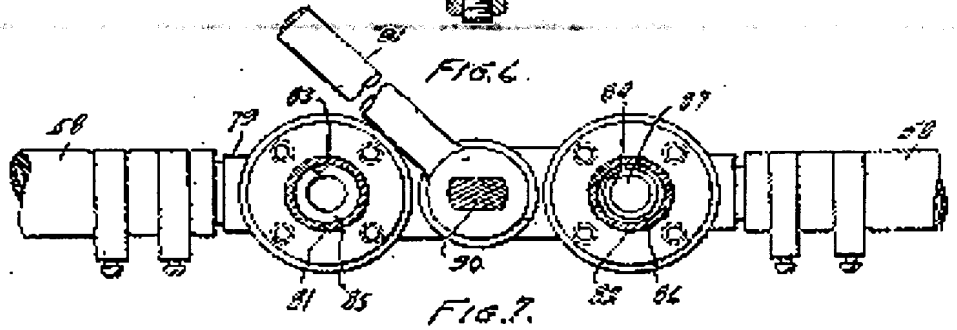
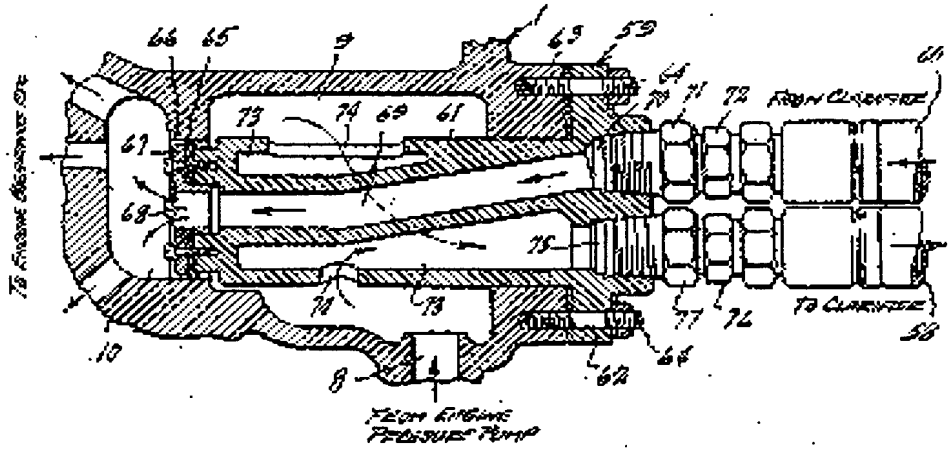
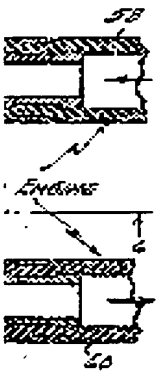
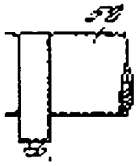


FIG. 7.







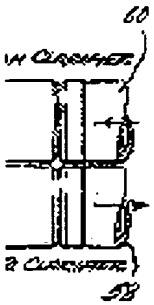
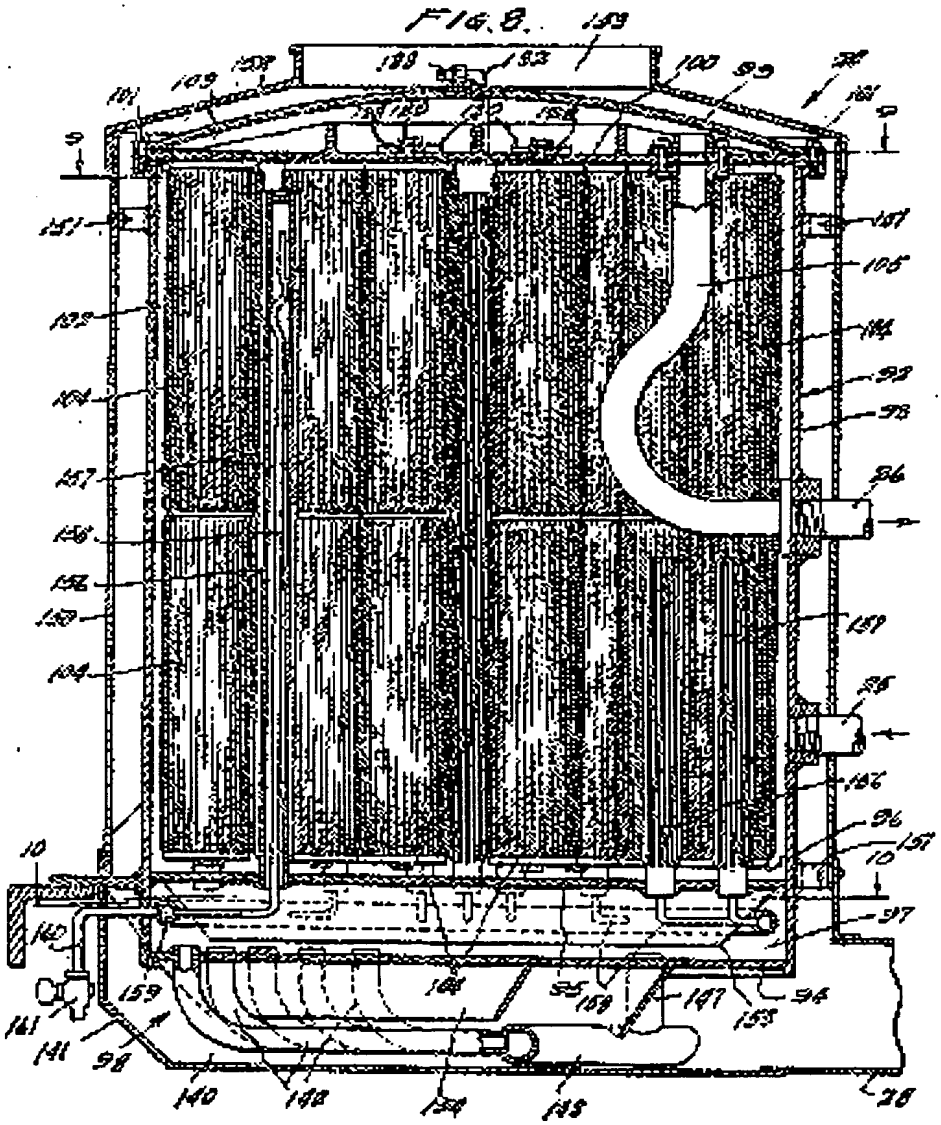
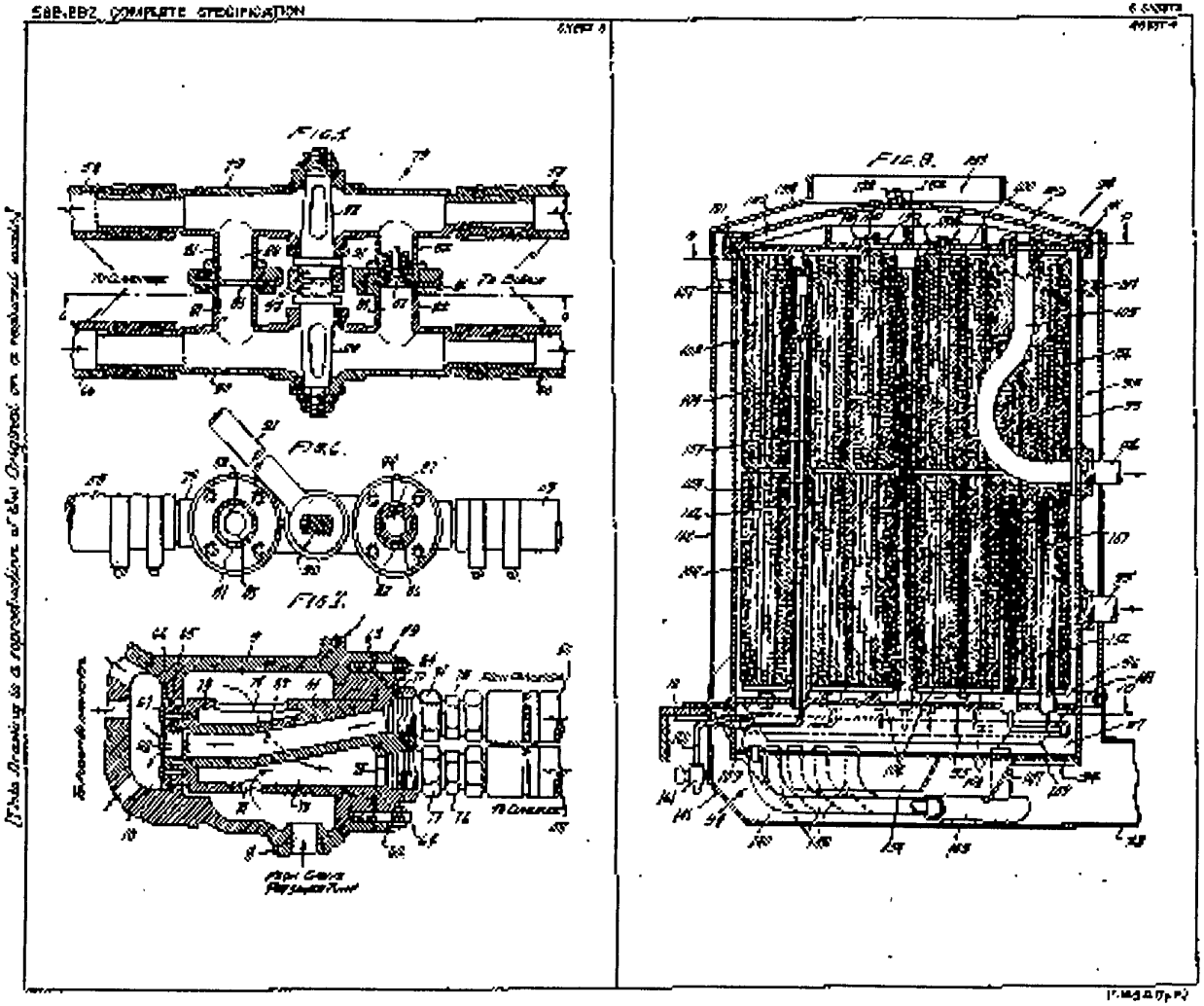


FIG. 8.





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SHEET.

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FIG. 9.

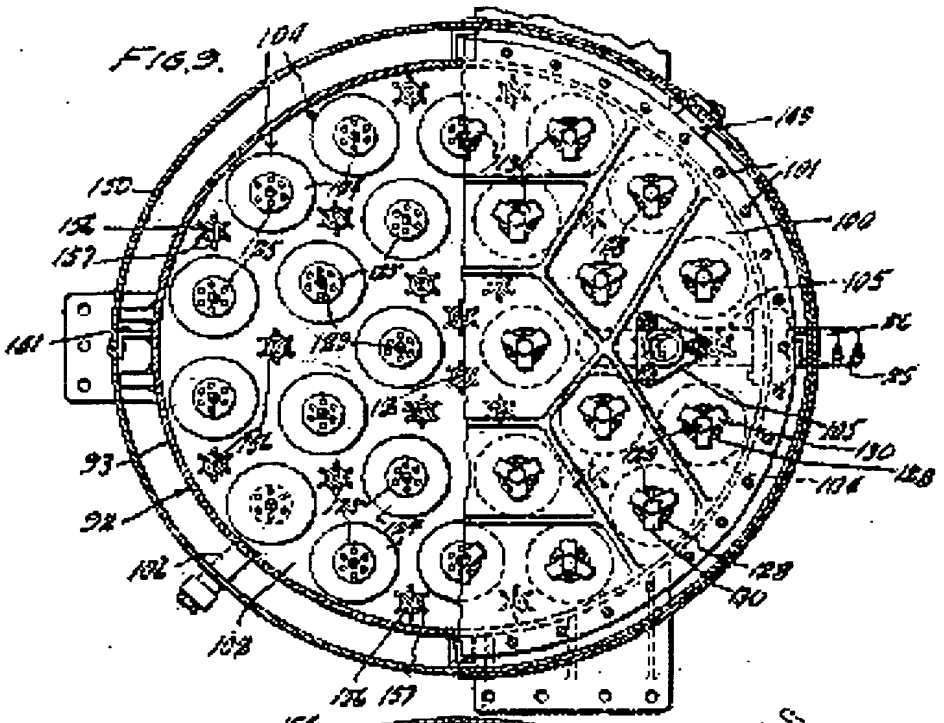
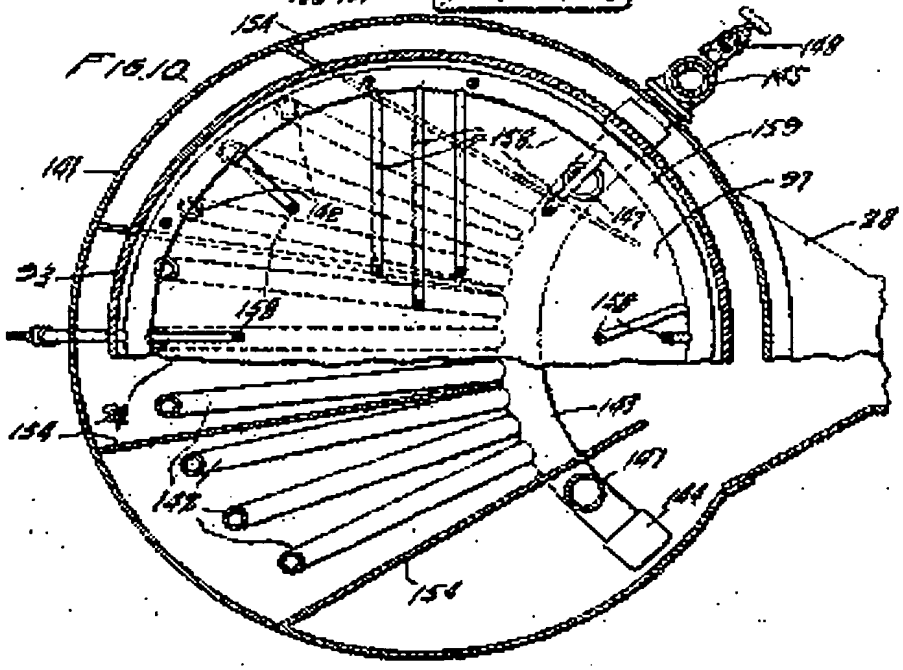


FIG. 10.



6 SHEETS

SHEET 5

SHEET 6

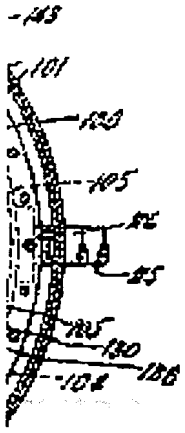
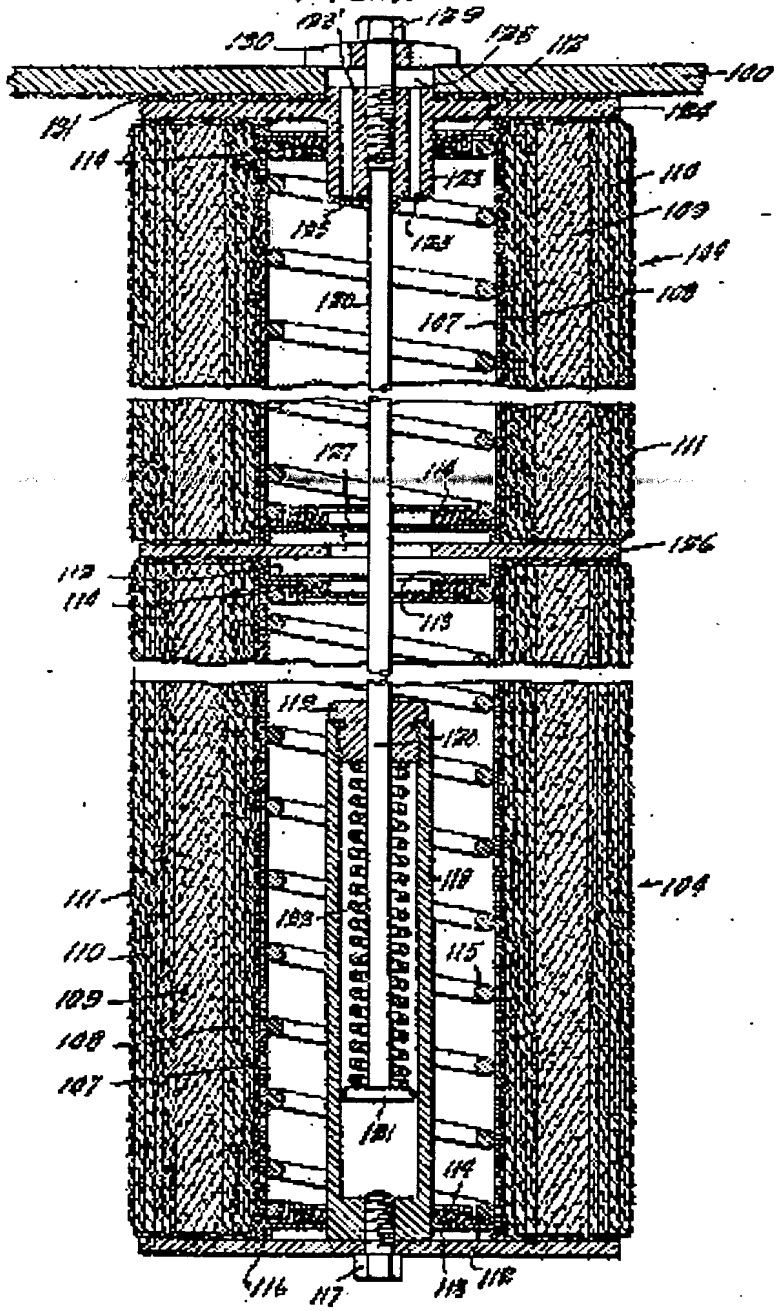
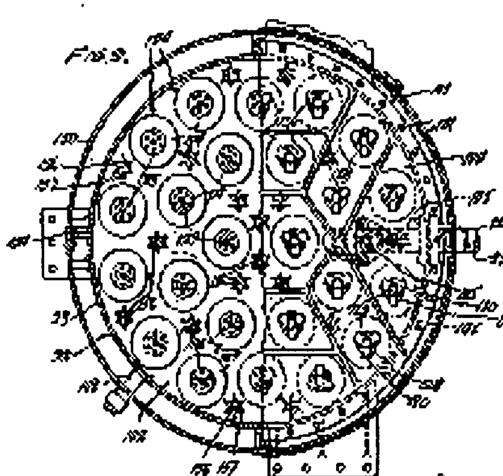
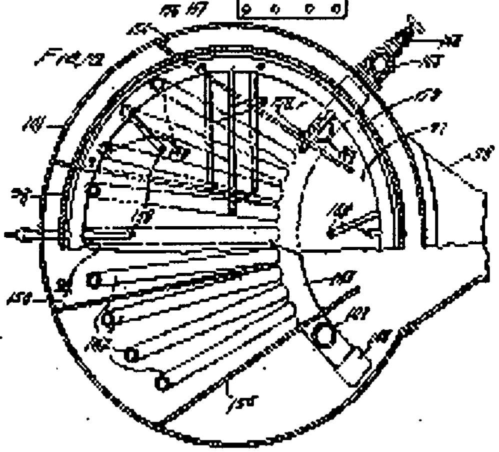


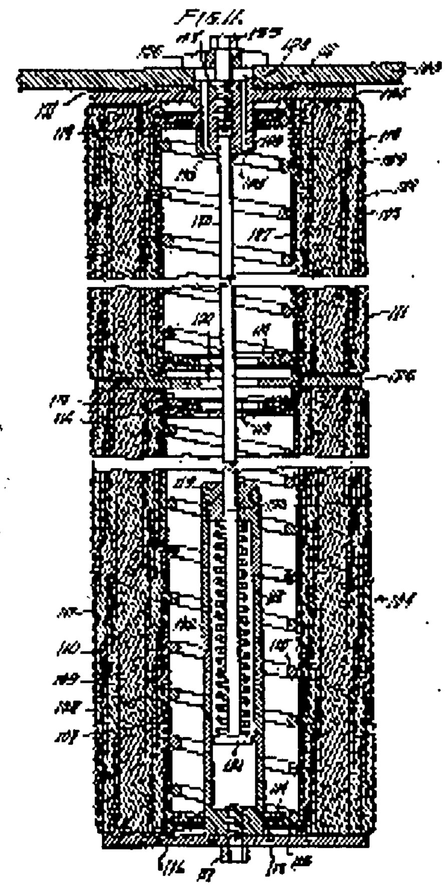
FIG. 11.



H.M.S.O. (T. P.)







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